

WHAT CLAIMED IS:

1. A light deflection element, comprising:

a pair of transparent substrates;

a liquid crystal composed of a chiral smectic C phase material with a homeotropic

5 alignment, being filled between the pair of transparent substrates; and

at least an electric field applying device, for activating an electric field in the liquid
crystal.

2. The light deflection element of claim 1, wherein the electric field applying
device is located at a position without overlapping an optical path of the light deflection

10 element, and is an electrode pair for generating the electric field that is substantially
perpendicular to a light deflection direction and a normal direction of the liquid crystal
composed of the chiral smectic C phase material.

3. The light deflection element of claim 1, further comprising a light deflection
position controlling device for controlling a light deflection position by performing a
temperature control to the light deflection element and the direction of the electric field
generated by the electrode pair.

4. A light deflection device, comprising

a first and a second light deflection elements, arranged in series along a light
propagating direction, wherein each of the first and the second light deflection elements
20 further comprises

a pair of transparent substrates;

a liquid crystal composed of a chiral smectic C phase material with a
homeotropic alignment, being filled between the pair of transparent
substrates; and

electric field applying devices, serving as electrode pairs for activating the electric fields in the liquid crystal;

a 1/2 wavelength plate interposed between the first and the second light deflection elements;

5 wherein directions of electric fields generated by two electrode pairs are perpendicular, and the electric field applying device is an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

5. A light deflection device, comprising

10 a first and a second light deflection element, arranged in series along a light propagating direction, wherein each of the first and the second light deflection elements further comprises

a pair of transparent substrates;

15 a liquid crystal composed of a chiral smectic C phase material with a homeotropic alignment, being filled between the pair of transparent substrates; and

20 electric field applying devices, serving as electrode pairs for activating the electric fields in the liquid crystal;

a polarization direction switching device interposed between the first and the second light deflection elements, for controlling a polarization direction of an incident light into the light deflection elements

wherein directions of electric fields generated by two electrode pairs forms a predetermined angle, and the electric field applying device is an electrode pair for generating the electric field that is substantially perpendicular to a light deflection

direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

6. The light deflection element of claim 1, wherein the electric field applying device is one set of electrode pairs and arranged between the transparent substrates.

5 7. The light deflection element of claim 6, wherein the electrode pairs are interleaved and arranged in a comb-teeth shape.

8. The light deflection element of claim 1, wherein the electric field applying device is two sets of comb-teeth shape electrode pairs and formed at interfaces between the liquid crystal and the transparent substrates, and directions of the electric fields generated by the two sets of comb-teeth shape electrode pairs are opposite.

10 9. A light deflection device, comprising:
a light deflection element composed of a chiral smectic C phase material ;
a polarization direction switching device, arranged at an incident side of the light deflection element for controlling a polarization direction of an incident light such that the polarization direction of the incident light is aligned with a light deflection direction occurred by the light deflection element.

15 10. The light deflection device of claim 9, wherein the light deflection element further comprises:

20 a pair of transparent substrates;
a liquid crystal composed of the chiral smectic C phase material with a homeotropic alignment, being filled between the pair of transparent substrates; and
at least an electric field applying device, for activating an electric field in the liquid crystal.

11. The light deflection device of claim 10, wherein the electric field applying

device is located at a position without overlapping an optical path of the light deflection element, and is an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

5 12. The light deflection device claim 10, wherein the electric field applying device is one set of electrode pairs and arranged between the transparent substrates.

13. The light deflection device of claim 12, wherein the electrode pairs are interleaved and arranged in a comb-teeth shape.

14. The light deflection device of claim 10, wherein the electric field applying device is two sets of comb-teeth shape electrode pairs and formed at interfaces between the liquid crystal and the transparent substrates, and directions of the electric fields generated by the two sets of comb-teeth shape electrode pairs are opposite.
10 15. A light deflection device, comprising:

15 a light deflection element composed of a chiral smectic C phase material; and
a polarization direction switching device, arranged at an incident side of the light deflection element for controlling a polarization direction of an incident light such that the polarization direction of the incident light is rotated by a predetermined angle relative to a light deflection direction caused by the light deflection element.

16. The light deflection device of claim 15, wherein the light deflection element
20 further comprises:

a pair of transparent substrates;
a liquid crystal composed of the chiral smectic C phase material with a homeotropic alignment, being filled between the pair of transparent substrates; and
at least an electric field applying device, for activating an electric field in the liquid

crystal.

17. The light deflection device of claim 16, wherein the electric field applying device is located at a position without overlapping an optical path of the light deflection element, and is an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

18. The light deflection device claim 16, wherein the electric field applying device is one set of electrode pairs and arranged between the transparent substrates.

19. The light deflection device of claim 18, wherein the electrode pairs are interleaved and arranged in a comb-teeth shape.

20. The light deflection device of claim 16, wherein the electric field applying device is two sets of comb-teeth shape electrode pairs and formed at interfaces between the liquid crystal and the transparent substrates, and directions of the electric fields generated by the two sets of comb-teeth shape electrode pairs are opposite.

21. A light deflection element, comprising:

a pair of transparent substrates;
a liquid crystal composed of a chiral smectic C phase material with a homogeneous alignment, being filled between the pair of transparent substrates; and

at least an electric field applying device located at a position without overlapping an optical path of the light deflection element, has an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

22. The light deflection element of claim 21, further comprising a light deflection position controlling device for controlling a light deflection position by performing a

temperature control to the light deflection element and the direction of the electric field generated by the electrode pair.

23. A light deflection element, comprising:

a pair of transparent substrates;

5 a liquid crystal composed of a chiral smectic C phase material with a homogeneous alignment, being filled between the pair of transparent substrates; and

at least an electric field applying device, being electrode pairs formed between the liquid crystal and the transparent substrates, wherein a direction of an incident light is different from a normal direction of the transparent substrate.

10 24. The light deflection element of claim 23, further comprising a light deflection position controlling device for controlling a light deflection position by performing a temperature control to the light deflection element and the direction of the electric field generated by the electrode pair.

25. A light deflection element, comprising:

a pair of transparent substrates;

15 a liquid crystal composed of a chiral smectic C phase material, and being filled between the pair of transparent substrates; and

20 at least an electric field applying device, wherein surfaces of the transparent substrates sandwiches the liquid crystal, and one transparent substrate is tilted with respect to another transparent substrate.

26. The light deflection element of claim 25, further comprising a light deflection position controlling device for controlling a light deflection position by performing a temperature control to the light deflection element and the direction of the electric field generated by the electrode pair.

v6. 27. A light deflection device, comprising:

a first and a second light deflection elements, separated by a predetermined distance along a light propagating direction, each of the first and the second light deflection elements further comprising:

5 a pair of transparent substrates;

a liquid crystal composed of a chiral smectic C phase material, and being filled between the pair of transparent substrates; and

10 at least an electric field applying device, wherein surfaces of the transparent substrates sandwiching the liquid crystal are opposite and tilted with respect to a light deflection direction.

v7. 28. The light deflection element of claim 27, further comprising a light deflection position controlling device for controlling a light deflection position by performing a temperature control to the light deflection element and the direction of the electric field generated by the electrode pair.

v8. 29. An image display device, at least comprising:

15 an image display element, comprising a plurality of pixels that are arranged in a two dimensional array, and capable of controlling a light according to an image information;

a light source for illuminating the image display element;

20 an optical element for observing image patterns displayed on the image display element;

a light deflection apparatus for deflecting an optical path between the image display element and the optical element for each of the sub-fields, wherein the sub-fields are divided in time domain from an image field, wherein the light deflection

apparatus is constructed from a light deflection means composed of a chiral smectic C phase material.

29. The image display device of claim 29, wherein the light deflection means further comprises:

5 a pair of transparent substrates;
a liquid crystal composed of the chiral smectic C phase material with a homeotropic alignment, being filled between the pair of transparent substrates; and
at least an electric field applying device, for activating an electric field in the liquid crystal.

10 30. The image display device of claim 30, wherein the electric field applying device is located at a position without overlapping an optical path of the light deflection element, and is an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

15 31. The light deflection element of claim 30, wherein the electric field applying device is one set of electrode pairs and arranged between the transparent substrates.

32. The light deflection element of claim 32, wherein the electrode pairs are interleaved and arranged in a comb-teeth shape.

20 34. The light deflection element of claim 30, wherein the electric field applying device is two sets of comb-teeth shape electrode pairs and formed at interfaces between the liquid crystal and the transparent substrates, and directions of the electric fields generated by the two sets of comb-teeth shape electrode pairs are opposite.

35. The image display device of claim 30, wherein the light deflection means further comprises a polarization direction switching device, arranged at an incident side

of the light deflection element for controlling a polarization direction of an incident light such that the polarization direction of the incident light is aligned with a light deflection direction occurred by the light deflection element.

35. The image display device of claim 29, wherein the light deflection means further comprises:

a pair of transparent substrates;
a liquid crystal composed of the chiral smectic C phase material with a homogeneous alignment, being filled between the pair of transparent substrates; and
at least an electric field applying device located at a position without overlapping an optical path of the light deflection element, has an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

36. The image display device of claim 29, wherein the light deflection means further comprises:

a pair of transparent substrates;
a liquid crystal composed of the chiral smectic C phase material with a homogeneous alignment, being filled between the pair of transparent substrates; and
at least an electric field applying device, being electrode pairs formed between the liquid crystal and the transparent substrates, wherein a direction of an incident light is different from a normal direction of the transparent substrate.

37. The image display device of claim 29, wherein the light deflection means further comprises:

a pair of transparent substrates;
a liquid crystal composed of the chiral smectic C phase material, and being filled

between the pair of transparent substrates; and

at least an electric field applying device, wherein surfaces of the transparent substrates sandwiching the liquid crystal are opposite and tilted with respect to a light deflection direction.

5 *γ 39.* The image display device of claim 29, wherein the light deflection means further comprises:

a first and a second light deflection elements, arranged in series along a light propagating direction, wherein each of the first and the second light deflection elements further comprises

10 a pair of transparent substrates;

a liquid crystal composed of the chiral smectic C phase material with a homeotropic alignment, being filled between the pair of transparent substrates; and

15 electric field applying devices, serving as electrode pairs for activating the electric fields in the liquid crystal;

a 1/2 wavelength plate interposed between the first and the second light deflection elements;

wherein directions of electric fields generated by two electrode pairs are perpendicular, and the electric field applying device is located at a position without overlapping an optical path of the light deflection element, and is an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.

γ 40. The image display device of claim 29, wherein the light deflection means

further comprises:

a first and a second light deflection element, arranged in series along a light propagating direction, wherein each of the first and the second light deflection elements further comprises

5 a pair of transparent substrates;

a liquid crystal composed of the chiral smectic C phase material with a homeotropic alignment, being filled between the pair of transparent substrates; and

electric field applying devices, serving as electrode pairs for activating the electric fields in the liquid crystal;

10 a polarization direction switching device interposed between the first and the second light deflection elements, for controlling a polarization direction of an incident light into the light deflection elements

15 wherein directions of electric fields generated by two electrode pairs forms a predetermined angle, and the electric field applying device is an electrode pair for generating the electric field that is substantially perpendicular to a light deflection direction and a normal direction of the liquid crystal composed of the chiral smectic C phase material.